

Attorney Docket No. 07402-026001
Serial No.: 09/838,707
Amendment dated November 12, 2003

Amendments to the Specification:

Please replace the paragraph beginning at page 6, line 2 with the following amended paragraph:

FIG. 1 shows an improved backside illuminated photodiode array 100 according to one embodiment of the invention. A semiconductor substrate 102 may be lightly doped to exhibit the n-type conductivity (or alternatively, the p-type conductivity) and have a high resistivity. For example, silicon may be used to form the substrate 102 with a resistivity on the order of about $10\text{k}\Omega\text{-cm}$. One side of the substrate 102, the front side, is selectively doped at different locations to form an array of heavily p-doped gate regions 104 that are separated from one another. A p-n junction is formed by each region ~~102~~ 104 and the surrounding n-region of the substrate 102 and functions as a photosensitive element (i.e., a photodiode) to detect photons within a spectral range. A circuit layer 110 is next formed over the front side of the substrate 102 and provides gate contacts and readout circuits to the photodiodes. The opposing side of the substrate 102, i.e., the backside, is configured to form a transparent conducting layer 106. This layer 106 may be internal to the substrate 102 by heavily doping the backside with the same type conductivity as the substrate, e.g., n-type dopants in the present example, to form a conducting crystalline

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bias electrode layer. Alternatively, this layer 106 may be external to the substrate 102 by engaging an external back contact layer to the outer surface on the backside of the substrate 102, e.g., a polycrystalline silicon back contact layer. For brevity, the acronym BEL is used below to denote a conducting bias electrode layer internal to the substrate.

Please replace the paragraph beginning at page 7, line 1 with the following amended paragraph:

The bias electrode layer or external back contact layer 106 is electrically biased to a different potential from the gates 104 so that a depletion region is formed near each p-n junction. The internal electric field within the depletion region collects photo-generated holes. The readout circuit (if provided) associated with each photodiode gate then detects the photon-induced charge and/or and produces a corresponding output signal.

Please replace the paragraph beginning at page 7, line 15 with the following amended paragraph:

An anti-reflection layer 120 is formed over the BEL 106 within each pixel. The anti-reflection layer 120 may be formed of any suitable materials such as a conducting layer of ITO or a non-

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conducting dielectric multi-layer stack. In many implementations, the anti-reflection layer 120 may be preferably formed by a dielectric multi-layer stack optimally matched to the refractive index of the BEL 106 according to well-known optical design procedures. Hence, the anti-reflection layer 120 can be configured independently from issues affecting the electrical performance of the backside and can be selected from a wide range of dielectric materials to achieve the optimal optical performance. Use of a such dielectric stack allows achievement of a high photon-collection efficiency, usually difficult to achieve using limited number of conducting anti-reflection materials.

Please replace the paragraph beginning at page 8, line 10 with the following amended paragraph:

Many imaging applications require detection of radiation in a spectral range that is out of the characteristic spectral response range of the semiconductor substrate. Conventionally, a scintillation crystal array is interposed between the source of radiation and the photodiode array to covert the incident radiation into secondary radiation in a spectral range detectable by the photodiode array. Each element of the scintillation crystal array is co-aligned with a photodiode of

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the photodiode array. Even if the incident particle is completely absorbed in a single scintillator crystal, secondary photons emitted at an angle from the output window of the scintillator may be collected by an adjoining photodiode, thereby producing crosstalk between adjacent photodiodes. Such crosstalk degrades the modulation transfer function and useful spatial resolution of the photodiode array as discussed above.